FCF Ground Segment

Joel Knapp

February 12, 2001

FCF Ground Segment Definition

- The Fluids and Combustion Facility (FCF) Ground Segment is comprised of the following elements:
  - Simulators for Principal Investigator (PI) development
  - Experiment Development Unit (EDU) for experiment development
  - Ground Integration Unit (GIU) for experiment verification
  - Flight Segment Support System (FSSS)
  - PTC Training Unit (PTCU)
  - Ground Handling & Testing Equipment
- The Ground Segment of the FCF provides the experiment user and on-orbit facility interface to the FCF on-orbit through the Telescience Support Center (TSC) via the ISS Ground Segment.
- The Ground Segment performs operations planning for the FCF and increment planning in conjunction with the Glenn Research Center (GRC) Microgravity Sciences division (MSD) Mission Integration Team (MIT) and ISS Ground Segment for FCF user payloads.
- The Ground Segment supports integration, assembly, acceptance, and delivery of reconfiguration products and data for FCF experiments.

Principal Investigator (PI) Simulators

- In order to demonstrate science feasibility as well as verify that FCF diagnostics meet expected PI performance requirements, FCF will provide PI teams access to FCF simulators.

- Access to PI Simulators will be provided by the following methods:
  - Near Term: Prior the development of simulators based on FCF flight unit designs support for PI development will be provided by the use of FCF breadboard and/or engineering model hardware on a non-interference basis. Additionally, PI simulator hardware consisting of commercial units or representations of unique FCF hardware will be provided to meet the PI experiment developer needs.
  - Long Term: A pool of simulators based on flight diagnostic package designs will be available to the PI development teams on an as needed basis.

Experiment Development Unit (EDU)

- The EDU will be composed of the following:
  - Engineering model hardware
  - Complete set of hardware as in flight unit (sans ARIS and SAMS)
  - Supported with necessary Ground Support Equipment (GSE) (including structural support)
- The EDU will be functionally equivalent to the flight unit.
- Available to payload developers for a variety of tests including interface testing, preliminary configuration selection, test sequence determination. Also used for sub-rack payload engineering model testing.

Ground Integration Unit (GIU)

- The GIU is comprised of the following:
  - Hardware identical to the flight unit except for
    - Aluminum rack
    - Ruggedized electronics
    - ARIS and SAMS.
  - Supported with necessary GSE (including structural support). The Payload Rack Checkout Unit (PRCU) will supply water, power and vacuum.
- The GIU will be functionally equivalent to the flight unit.
- Used by PI's for integration verification, Flight S/W update validation, trouble shooting, and following on orbit progress. Procedure development, verification of system level requirements between racks.

Flight Segment Support System (FSSS)

- The Flight Segment Support System (FSSS) is comprised of the functions required to support nominal and troubleshooting operations.
- Interfaces with the TSC will provide the necessary functionality to interact with the onboard FCF system to conduct science and maintenance operations.
- The Ground Integration Unit (GIU) will provide the functions required to assist in troubleshooting the flight system as well as providing a method of baseline data collection to compare with science data gathered on orbit.
- Functionality required to interface with and operate the GIU will be provided.

Ground Segment Phasing

PI Breadboard & Functional Model H/W

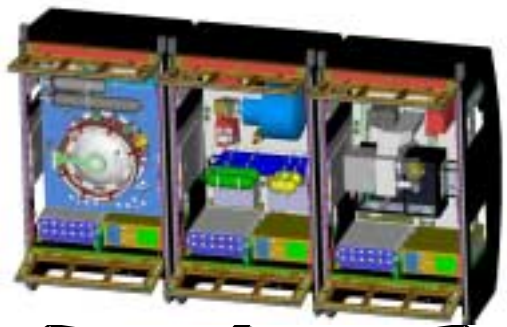
Request to Test

FCF Simulators

PI Functional Model H/W

Request to Test

EDU



GSE Chiller

GSE Power

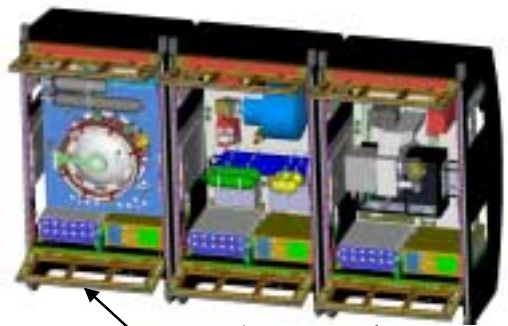
GSE Vacuum

GSE

PI Flight H/W

Request to Test

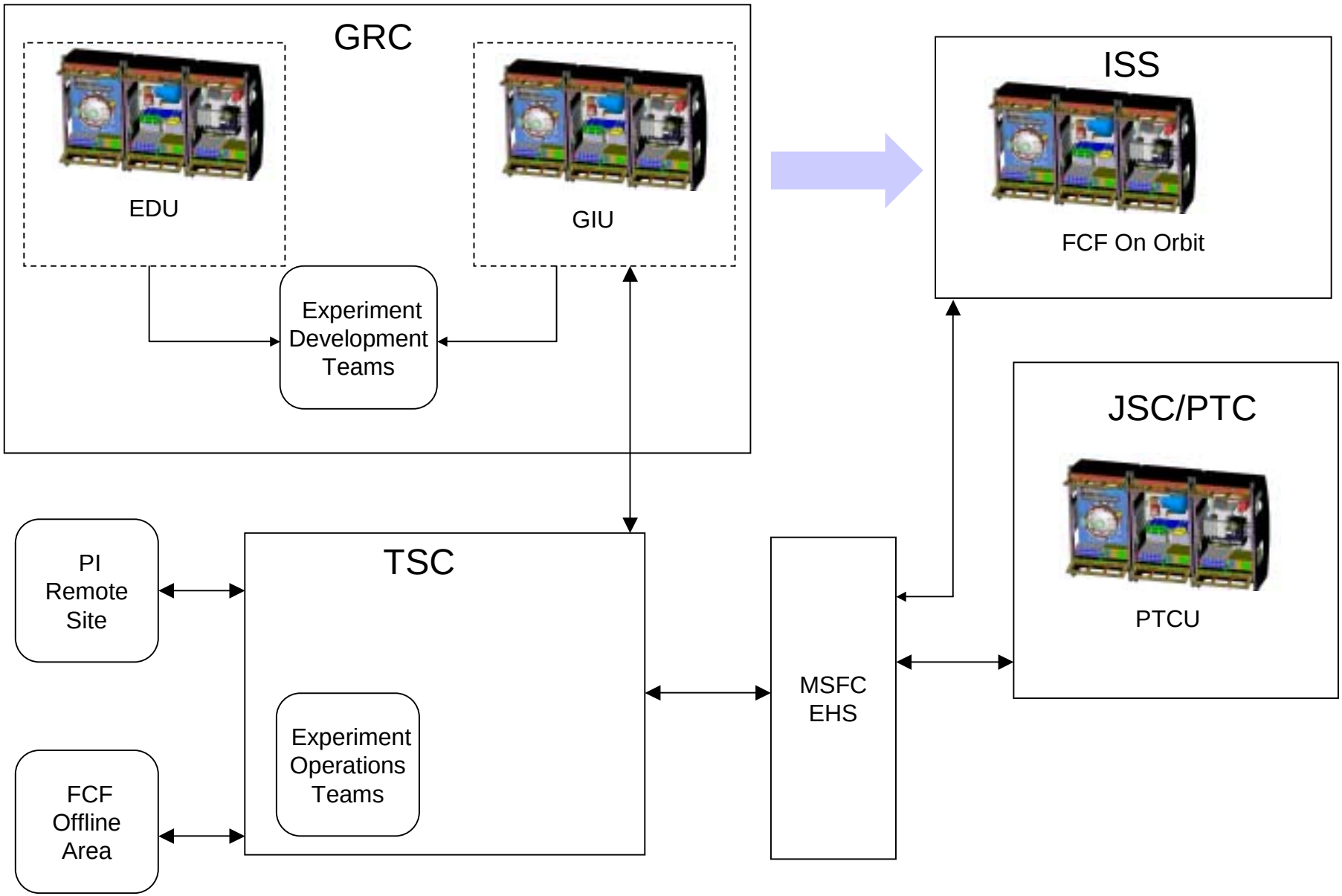
GIU



PRCU

RDR **FIVT**

Ground Segment Interfaces



Required Facilities

- FCF package buildup will done at contractor facilities
- Rack level integration and test will be done in Building 333
- Testing will be accomplished at
  - GRC Facilities
    - Microgravity Emmisions Lab (MEL)
    - EMI Lab
    - Acoustic Lab
    - Vib lab
  - TBD offgassing test facility (MSFC or WSTF)

FCF Training PTCU

FCF Training

- Training Strategy Team (TST) established with participation of JSC and MSFC training organizations.
- Meet bi-weekly to determine FCF training requirements. Focus is currently CIR due to scheduled launch date.
- Accomplishments include:
  - Defined the CIR task to be trained
  - Identified the need for Part Task Trainers (PTT)
  - Allocated CIR task to be trained using PTT
  - Identified the need for Computer Based Training (CBT)
  - Allocated CIR task to be trained using CBT
  - Identified the need for Payload Training Center Unit (PTCU)
  - Allocated CIR task to be trained using PTCU
- Ongoing activities include:
  - Working to define training duration associated with each task
  - Begin FIR training task development
- Simulator Definition Documents developed outlining the requirements the PTCU will have to meet based on generic Payload Simulator Requirements Documents (PSRD).

FCF PTCU Description

- The FCF PTCU will support the following training:
  - Payload Science/Operations
  - Payload Proficiency
  - Payload Refresher
  - Payload Complement
  - Crew Multi-Segment
  - Integrated Payload-Only Simulations
  - Joint Multi-Segment
- The FCF PTCU will support the following Space Station Training Facility (SSTF)/Rack Interfaces:
  - Payload Ethernet LAN and Payload Ethernet Hub Gateway (PEHG)
  - Mil-Std-1553B Bus
  - Payload Simulation Network (PSimNet)
  - Portable Computer System (PCS)
  - Signal Conversion Equipment (SCE)
  - Instructor/Operator Station (IOS)
  - Video Switching and Distribution (VSD) Subsystem
  - Electrical Power

FCF PTCU Description – Continued

- The PTCU will provide the following Space Station Training Facility (SSTF) model/Rack interfaces:
  - Onboard Computer System (OBCS) Model
  - Communications and Tracking (C&T) Model
  - Environmental Control and Life Support System (ECLSS) Model
  - Electrical Power System (EPS) Model
  - Guidance, Navigation, and Control (GN&C) Model
  - Thermal Control System (TCS) Model
  - Environment (ENV) Model
- Rack-mounted components: Rack Door, CIR Optics Bench, Fuel/Oxidizer Management Assembly (FOMA), Combustion Chamber
- Replaceable diagnostics: CIR Input/Output Processor (IOP), Air Thermal Control System (ATCS), Electrical Power Control Unit (EPCU), Science Specific Hardware
- Copies of the common simulation components will be produced to allow for unique command and response from each rack in support of Payload Complement Training

CIR Part Task Trainers (PTT)

The following PTTs have been identified:

- Optics Bench/Diagnostic
- Input/Output Processor (IOP)
- Fuel/Oxidizer Management Assembly (FOMA)

The list of tasks assigned to the PTT are:

Set up:
Configure & install science diagnostics and Image Processing Package (IPP)
Use universal handle to install and remove diagnostic packages
Data Transfer:
Remove hard drive from the IOP if the volume of data is too great to downlink
Maintenance Operations
Remove and replace the cards within the IOP
Remove and replace pressure release valves on the gas chromatograph
Perform card level replacement in Input/Output Processor (IOP)
Turn on ATCU and check rack door seals for air leakage
Remove and replace solenoid valves and pressure regulators on FOMA manifold
Remove and replace filters at gas inlet of FOMA manifold

CIR Computer Based Training (CBT)

The list of tasks assigned to the CBTs are:

Science Overview
State the generic science objectives
State the generic science constraints
CIR Overview
Identify the hardware components of the CIR and the functionality of each
Identify the CIR interfaces to the ISS
Identify the interfaces between the combustion chamber and the CIR rack
CIR Facility Transfer & Installation
* Describe the process of transferring the CIR to and from ISS
* Describe the CIR facility installation and checkout
Data Transfer:
Remove hard drive from the IOP if the volume of data is too great to downlink

Maintenance Operations
Remove and replace the cards within the IOP
Remove and replace pressure release valves on the gas chromatograph
Perform card level replacement in Input/Output Processor (IOP)
Turn on ATCU and check rack door seals for air leakage
Remove and replace solenoid valves and pressure regulators on FOMA manifold
Remove and replace re-circulation pump on back of combustion chamber
Remove and replace filters at gas inlet of FOMA manifold

CIR Payload Training Center Unit (PTCU)

The list of tasks assigned to the CBTs are:

CIR Rack Installation
Perform CIR rack installation
Remove launch restraining bolts on rack doors
Remove launch restraints associated with ATCU components
Remove launch restraining bolts for optics bench
Remove launch restraints on IOP
Connect data cables to IOP
Install FOMA control unit
Install IPSU on the optics bench
Remove structural fasteners in upper and lower doors and replace with a plug to prevent air leakage
Connect CIR to ISS Interface connections
Connect the CIR to the ARIS

Set up:
Install CIR Gas Bottles
Install and remove filter cartridges
Open CIR rack door
Deploy CIR optics bench
Configure & install science diagnostics and Image Processing Package (IPP)
Use universal handle to install and remove diagnostic packages
Configure CIR patch panel on optics bench
Removal and replace the CIR chamber windows
Lock optics bench to ISPR
Open the CIR combustion chamber
Install Experiment Mounting Structure (EMS)
Install CIR experiment hardware in chamber
Close the CIR combustion chamber
Close CIR rack door
Attach the CIR laptop

CIR Payload Training Center Unit (PTCU) – Continued

Start up:
Activation and startup of ARIS
Apply Power to CIR
Perform leak check on combustion chamber (performed after hazardous test points)
Perform self-test on CIR components (e.g. IOP, EPCU, Laptop, etc.)
Configure:
Configure additional CIR hardware components (e.g. FOMA)
Command cameras and illumination packages to appropriate settings
Open the gas supply manual valves
Fill the combustion chamber
Stabilize and sample the combustion chamber
Operate the flow control valves to regulate the flow rate in the WTCS.
Experiment Execution:
Command ignition of CIR experiment
Observe combustion phenomena occurring within the CIR chamber
Verify CIR combustion phenomena is complete

Test Chamber Recycle:
Clean up the combustion chamber while combustion chamber door is closed
Sample combustion chamber
Evacuate the combustion chamber
Operate the motorized shut-off valve for the VES service.
Data Transfer:
Transfer health & status data to the ground
Use the laptop to transfer data from the IOP to the ground
Copy Data from the Image Processing and Storage Unit (IPSU) to the Input/Output Processor (IOP) prior to downlink
Command Image Processing and Storage Units (IPSUs) on or off.
Uplink files to IOP
Shutdown:
Shut off power to the Fluids and Combustion Facility (FCF)

CIR Payload Training Center Unit (PTCU) – Continued

Maintenance Operations
Remove and/or replace the CIR Electrical Power Conversion Unit (EPCU)
Remove and replace launch restraining bolts on IOP and EPCU at first maintenance event
Remove & replace the Input/Output Processor (IOP)
Remove and replace the cards within the IOP
Remove & replace the FOMA Control Unit (FCU)
Remove and replace pressure release valves on the gas chromatograph
Remove & replace the ATCS fan
Service the ATCS heat exchanger
Vacuum the ATCS fan
Remove & replace the WTCS controller
Remove & replace the WTCS valve package
Remove & replace the combustion chamber door seal
Remove & replace the combustion chamber window seals

Maintenance Operations - Continued
Turn on ATCU and check rack door seals for air leakage
Connect & disconnect the GN2, VES & VRS services to interface panel on back side of optics bench
Operate the manual shut-off valve for the GN2 supply and the VRS service (off-nominal ????? - TBD)
Clean-up combustion chamber with door open
Remove and replace re-circulation pump on back of combustion chamber
Remove and replace gas chromatograph instrumentation package
Remove and replace fan in combustion chamber
Remove and replace rack door seals
Remove and replace fire extinguisher hole membrane
Remove and replace IPSU

CIR Payload Training Center Unit (PTCU) – Continued

System Malfunctions
*** Perform diagnostic troubleshooting
*** Perform power system troubleshooting
*** Perform Input/Output Processor (IOP) troubleshooting
*** Perform Environmental Control System (ECS) troubleshooting
*** Perform CIR system safing
*** Perform manual valve override for chamber venting in a powered down state
*** Unable to de-mate gas bottles due to excessive pressure - perform manual bleed valve operation
*** Opening rack doors at improper times causes laser light to be powered down (Malfunction or nomial ops??? TBD)

FCF Training

Summary

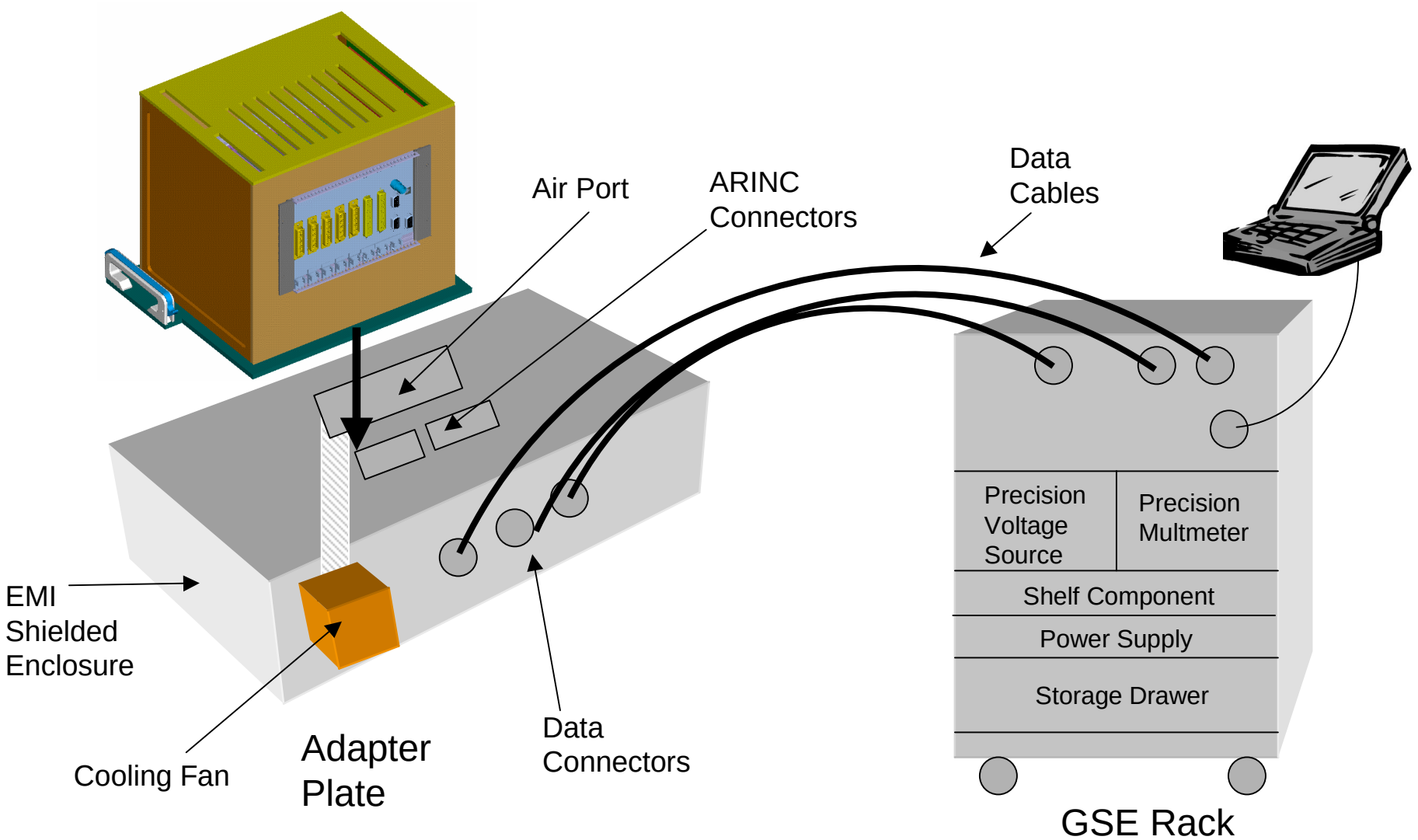
- The Training Strategy Team (TST) has defined the training task for the CIR.
- FIR training tasks being developed.
- Part Task Trainers (PTT) have been identified.
- Determined that a trainer is not required for JSC Building 9 (SVMF).

Ground Support Equipment (GSE)

Ground Support Equipment (GSE)

- Common Ground Support Equipment is used to support the FIR, SAR and CIR
  - Rack Handling Adapters
  - Optics Bench support hardware
- Test Support Equipment (TSE) will be used to functionally check subassemblies/ORUs
  - IPSU simulators for diagnostic package tests
- Mechanical adapter plate with insert to support different package testing
  - Includes UML interface
  - Provide air cooling for mounted Components
- Common TSE electronics rack approach can be configured to support multiple tests

Generic Ground Support Equipment (GSE) Concept



Major Common Elements

ASSEMBLY TESTED	GSE/FSE	NAME	FUNCTION
Optics Bench & Chamber	GSE	Rack Handling Adapter	Support equipment that picks up the attachment points of the rack and will hold the rack square and add rigidity.
Optics Bench & Chamber	GSE	Rack Base/Counterweight	Support equipment that will hold the base of the rack and allow for the deployment of the Optics Bench
Optics Bench & Chamber	GSE	Optics Bench Rotational Equipment	Support equipment that attaches to the Optics Bench after deployment and allows the Optics Bench to be rotated
Optics Bench & Chamber	GSE	Gas Supply Bottle Support Equipment	Equipment used to support the gas supply bottles (Gas Supply and Distribution Package) in a 1g environment.
Optics Bench & Chamber	GSE	Optics Bench Anti-Rotation Pins	Pins are required that prevent the Optics Bench from rotating prior to the GSE attachment (described above). The brake mechanism has been sized to handle the Optics Bench on-orbit. However, under 1g, the brake can be easily overcome and the Optics Bench
Optics Bench & Chamber	GSE	Optics Bench Mass Compensator	Support equipment needed to off load the weight of the Optics Bench from the Slide Mechanism. The travel stops and ability to move and brake the Optics Bench will be evaluated
Rack Level System Level	GSE	Payload Rack Checkout Unit (PRCU)	Checkout of rack system and subsystems functionality.
Rack Level System Level	GSE	UML Connectivity and Communications Tester/Testbox	Place at a UML location and test for power, ethernet and CANbus.
Rack Level System Level	GSE	Laptop w/Ethernet	User interface computing equipment to run the rack on the ground in various locations
IOP	TSE	IOP Functional Equivalent Unit (FEU)	The IOP FEU is an IOP simulator with all flight IOP hardware except the HRDL, CVIT, and power supplies, packaged in a commercial card cage. This system is used to check out all IOP flight interfaces including IOP rack to rack interfaces.